

Echocardiographic screening of schoolchildren in American Samoa to detect rheumatic heart disease: a feasibility study

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Background: We report a practical and affordable pilot echocardiographic screening model for the detection of rheumatic heart disease (RHD) in Samoan children.

Materials and methods: Following a brief training period, three medical students recruited and screened 58.3% (N = 140) of schoolchildren aged 7–18 years on the remote Pacific island of Ta'u, American Samoa, performing echocardiography with a SonoSite® portable ultrasound machine.

Results: None of the echocardiographic images obtained showed significant abnormality consistent with RHD on their review by two pediatric cardiologists on Oahu, Hawaii.

Conclusions: The implementation of echocardiographic screening in resource-poor regions with high rates of acute rheumatic fever and RHD, such as American Samoa, is feasible with limited training of personnel.

Keywords: pediatric, RHD, Samoa, schoolchildren, screening

Introduction

Acute rheumatic fever (ARF) and rheumatic heart disease (RHD) are worldwide problems, with RHD alone causing 233,000–492,000 deaths each year.¹ Although ARF and RHD have declined dramatically in the US, prevalence in the developing world remains high. Polynesian populations, such as Māori in New Zealand, have been reported to have higher rates of ARF and resulting heart disease.^{2,3} Similarly, Samoan and other Polynesian ethnic groups have higher rates of RHD in Hawaii.^{4,5}

Samoans on the Pacific island of American Samoa may have even higher rates of ARF with lower annual income, reported crowded living conditions, and limited access to health care.⁵ A retrospective chart review previously showed 30–35 new ARF patients diagnosed each year in the small population of American Samoa (total of 57,794 people, 21,927 children under 15 years of age, July 2005 estimate). Of the 148 charts reviewed, only two patients had echocardiograms performed during their initial presentation, and in 21 patients (14%) the diagnosis was made after 2 weeks to 6 years of their initial presentation when they developed murmurs and clinical heart disease.⁶ The neighboring nation of Independent Samoa has been suggested to have one of the highest prevalence rates of RHD in the world.⁷ These studies showed that early diagnosis of silent carditis cases in resource-poor areas such as American Samoa with high ARF and resulting heart disease rates is critical.

If early diagnoses of mild or so-called silent carditis patients had been made, these patients could have been started on secondary prophylaxis with penicillin, which has been shown to be the most efficient and cost-effective strategy to reduce the burden of RHD. If secondary prophylaxis is initiated in time, the limited health care funds of

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resource-poor settings with disparity populations could be shifted from expensive cardiac surgery for severe RHD to the development of robust secondary prophylaxis programs. Echocardiographic screening of individuals at highly endemic areas of rheumatic fever has been found to be more sensitive and specific than auscultation in detecting carditis.⁸ Recent reports have demonstrated the utility of echocardiographic screening in the Pacific nations of Tonga⁹ and Fiji.¹⁰

In American Samoa, use of echocardiography is limited to quarterly adult cardiologist visits, making the diagnosis of subclinical or asymptomatic carditis more difficult. These observations and preliminary studies prompted us to do a feasibility study for echocardiographic screening of Samoan children.

Materials and methods

This study was approved by the American Samoa Department of Health Institutional Review Board and Department of Education. Echocardiogram screenings were conducted for 140 school children on the remote island of Ta'u, American Samoa, in August 2009. Ta'u island has a total population of 850 and a pediatric population of approximately 240 children aged 8–17 years.¹¹ Screenings were conducted over 3 days at Manu'a High School, Faleasao Elementary School, and Fitiuta Elementary School. These represented all the schools on the island. All children aged 7–18 years on the island were eligible for screening, and a participation rate of 58.3% (140/240) was achieved. A lack of parental permission slip returned was the most common reason for those children not screened. No child was receiving penicillin prophylaxis at the time of screening. The mean age was 12.5 years. A total of 44.3% (N = 62) of participants were girls and 55.7% (N = 78) were boys. Informed consent was obtained from all participants' families via a consent form in the Samoan language. The children and families were notified that this would be a feasibility study and that the results obtained from the study might not be diagnostic. Information on age and village were obtained from each student, with parental consent, prior to screening, and echocardiographic screenings were conducted in a private room in each school. Screening took approximately 3–8 minutes per child. Two medical students were trained by a cardiologist for 6 hours to obtain echocardiographic pictures using a SonoSite® 180 portable ultrasound machine (SonoSite, Inc., Bothell, WA, USA).

Each echocardiographic exam was limited to left-sided cardiac structure, namely mitral and aortic valves. A two-dimensional study and a color flow examination in standardized echocardiographic views were carried out, including apical four-chamber, parasternal long-axis and

parasternal short-axis views. Each echocardiographic study was recorded continuously using a portable video recorder (ARCHOS® 5; Archos Inc., Greenwood Village, CO, USA). The recorded studies were stored in the hard drive of the portable recorder in DivX format. Each stored study was later transferred to a personal computer and reviewed using a commercially available media player (DivX® Player; DivX, San Diego, CA, USA). Subclinical RHD was diagnosed if there were at least two morphological rheumatic valvular features associated with any Doppler-detected valvular regurgitation seen in at least two planes.⁸ Each echocardiographic study was reviewed by two independent pediatric cardiologists experienced in diagnosing RHD. Each reviewer was blinded to any clinical data. The results from each reviewer were compared, and only concordant positive results for RHD were considered RHD. Any positive results were referred to the LBJ Tropical Medicine Center in Pago Pago, American Samoa.

Results

The diagnostic quality of the obtained images was not optimal due to the limitation of the echocardiography machine. In 44 (31.4%) children, the images were categorized as equivocal due to the image quality when reviewed by two pediatric cardiologists on Oahu, Hawaii. Concordance between the two reviewers was 100%. None of the images showed significant abnormality consistent with RHD.

Discussion

The results from this brief 3-day feasibility study were encouraging, as they demonstrated that echocardiographic screening is practical in rural American Samoa, even with very limited personnel training. Although diagnostic quality of the images obtained was not ideal, this was due to equipment inadequacy rather than user error. Although our screening results were equivocal in 31.4% of children, this was due to poor image quality preventing a definitive ruling out of more subtle abnormalities. Both reviewing cardiologists agreed that significant abnormalities, such as regurgitation or valve changes, were not present in any of the images. No congenital abnormalities were observed.

Echocardiographic screening of individuals in highly endemic areas of rheumatic fever has been reported to be effective. Marijon et al found that 2%–3% of school-age children in Cambodia and Mozambique have RHD, almost all of whom are previously undiagnosed, and further suggested that if only clinical diagnosis had been relied on, approximately 90% of echocardiographically detected cases would have been missed.¹² In addition to RHD, echocardiographic screening could detect other heart diseases, including congenital heart

anomalies, cardiomyopathies, and missed Kawasaki disease cases. The cost of a better portable echocardiographic device is approximately \$15,000, and educating assistants to use echocardiography in diagnosing clinical and subclinical RHD is feasible.⁸ Approximately 1000 students start high school each year in Samoa. If all of these students were screened, the cost of screening may well be less than the health care fund spend on complicated RHD patients in Hawaii.

Because the goal of this study was to assess the feasibility of a screening echocardiogram program by personnel with limited training, cardiac examinations were not performed. Echocardiographic screening along with cardiac examination would obviously increase the detection rates for subclinical cardiac disease. Although Samoans are at increased risk of ARF, we do not have a reported incidence rate among children.⁶ The current small feasibility study did not show any children with significant heart disease, which indicates the need for larger-scaled studies. Larger community-based studies that follow this population over an extended period of time would show the extent of subclinical disease, its natural progression, and RHD improvement with the use of benzathine penicillin treatment in these patients.

It is not acceptable to leave asymptomatic carditis cases undiagnosed and these children at risk for recurrence of rheumatic fever simply because echocardiographic screening is seen as an inappropriate use of modern technology in these areas. This study defines a model of echocardiographic screening that is practical, affordable, and applicable in rural American Samoa. If used with a higher-quality echocardiography machine, the results obtained from students may guide regional health service planning and accurately identify affected children to be targeted for secondary prevention. These may have a major impact for decreasing disparities in cardiovascular health among Samoan children. Our results also showed that the study enrollment goal was achievable, as 58.3% of all schoolchildren in the desired age range were screened with only 2 days' notice. A more intensive school-based outreach could achieve significantly higher participation rates.

Conclusion

In conclusion, this study showed that the implementation of echocardiographic screening in resource-poor regions with

high rates of ARF and RHD is feasible with limited training of personnel, provided that a higher-quality portable echocardiography machine is utilized. The application of this relatively simple approach may be used in the field by minimally trained individuals, which holds significant promise for geographically isolated areas of the developing world.

Acknowledgements

We would like to acknowledge Dr Todd Seto's support in training medical students and loaning the echocardiography machine for this study. We would also like to thank Francine Amoa, David Addison, Dr Malouamaua Puleisili Tuiolosega, Ivan Tuliau, and especially the people of Ta'u, Faleasao, and Fitiuta villages.

Disclosure

The authors report no conflicts of interest in this work.

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